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A New High-Elevation *Bavayia* (Reptilia: Squamata: Diplodactylidae) from Northeastern New Caledonia[1]

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ABSTRACT: A new species in the diplodactylid gecko genus *Bavayia* is described from the northern ranges of Province Nord, New Caledonia. The new gecko is a gracile, large-bodied form distinguished from its congeners by the morphology of digit I of the manus and pes, and the presence of two long rows of preanal pores that extend onto the thigh. The two known specimens are from high elevation in closed forest. This is the first species of diplodactylid gecko apparently restricted to high elevations in New Caledonia and joins a growing group of high-elevation skinks that have been described in recent years.

THE GENUS *Bavayia* was initially erected by Roux (1913) to include two species of small, endemic New Caledonian geckos, *B. sauvagii* (Boulenger) and *B. cyclura* (Günther). Roux (1913) described three new forms, each of which he considered to be subspecies of one of the previously known forms. Sadlier (1989) elevated these three taxa (*B. ornata, B. montana, B. crassicollis*) to specific status and described two additional taxa (*B. septuiclavis* and *B. validiclavis*). Intensive and extensive sampling on the New Caledonian mainland since that time has revealed a number of additional species, including both novel morphologically distinctive forms (*B. exsuccida, B. pulchella* [Bauer et al. 1998]) and more cryptic species bearing a superficial resemblance to one of the more widespread species in the genus (*B. geitaina, B. robusta* [Wright et al. 2000]). Despite the recognition of these new taxa, the geckos currently referred to *B. sauvagii* and *B. cyclura* still each constitute a heterogeneous assortment of superficially similar taxa (Bauer 1990). Although many of these undescribed forms may be diagnosed morphologically by only minor differences in scalation or subtleties of coloration pattern, the exploration of unique or distinctive habitats within New Caledonia still occasionally reveals highly distinctive new taxa exhibiting localized endemism within the island. We here present a description of such a distinctive form that is apparently restricted to high elevations in the Mt. Panié Massif of northeastern New Caledonia.

MATERIALS AND METHODS

Specimens from the collections of the Australian Museum (AMS) and Muséum National d'Histoire Naturelle, Paris (MNHN), were examined under a dissecting microscope (Nikon SMZ-10) and measurements were taken with digital calipers (Brown and Sharpe Digit-cal Plus). Radiographs were prepared using a cabinet X-ray system (Faxitron) with exposures of 40 sec at 40 kV. The following measurements were recorded for each specimen: snout-vent length (SVL); tail length (TL); axilla-groin length (AG); head length from retroarticular process of mandible to snout tip (HL); maximal head width (HW); maximal head depth (HD); eye diameter (ED); distance from posterior border of orbit to anterior margin of ear (EE); and distance from anterior border of orbit to

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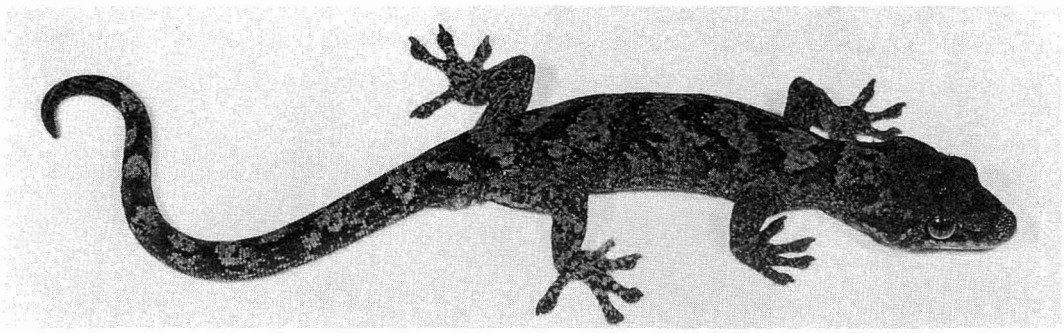

FIGURE 1. Paratype of *Bavayia madjo* (AMS R149329). Note the gracile body, slender tail, and large head.

tip of snout (ES). Subdigital lamellae (SDL) were counted from the proximalmost enlarged setae-bearing lamellae to the distal tip of the digits. In the case of digit I, the single apical plate was included in lamellar counts. Vertebral and tooth counts as well as phalangeal formulas and information about cloacal bones were derived from X rays.

SYSTEMATICS

Bavayia madjo Bauer, Jones & Sadlier, n. sp.

Figures 1–2

TYPE MATERIAL: Holotype: MNHN 1998.0467, adult male, Mt. Ignambi (1100 m elevation), Province Nord, New Caledonia, 20° 28″ S, 164° 36″ E, collected by J. Jones, 6 August 1998. Paratype: AMS R149329, Mt. Panié (890 m), Province Nord, New Caledonia, 20° 34′ 04″ S, 164° 46′ 25″ E, collected by R. Sadlier, 6 June 1996.

ETYMOLOGY: The species name *madjo* is a term for a small gecko (i.e., a gecko other than *Rhacodactylus* spp.) in Djahoue, a Kanak language spoken in the northeastern ranges of Province Nord where this species occurs.

DIAGNOSIS: A large, gracile species of *Bavayia* (maximum SVL 75 mm) that can be distinguished from its congeners by the following combination of characteristics: claw of digit I positioned adjacent to a single enlarged, medial apical scansor; two to three rows of preanal pores in males, anteriormost complete row with 28–29 pores, second row with 22–24 pores divided in the ventral midline by a gap of 1–3 poreless scales; venter a pale dull gray in life; dorsal pattern distinct with a series of four dark cross bands or chevrons between limb insertions, contrasting with lighter background color; body and tail slender; head relatively large; midbody scale rows 145–154; 13–14 lamellae on digit IV of pes.

DESCRIPTION (holotype data followed by paratype data in parentheses): SVL 72.0 (75.2) mm; TL 86.0 (85.0) mm; AG 27.3 (33.3) mm; HL 20.4 (21.0) mm; HW 15.0 (13.7) mm; HD 10.6 (9.8) mm; ES 8.8 (8.1) mm; ED 4.6 (5.3) mm; EE 6.9 (6.8) mm. Body moderately long (AG = 38–44% SVL), gracile, slightly depressed. Head oblong, large (HL = 28% SVL), relatively wide (HW = 64–74% HL) and high (HD = 49–52% HL), clearly distinct from neck; interorbital/frontal region somewhat depressed, parietal region weakly depressed, canthus weakly inflated; snout relatively long (ES = 39–43 % HL), much longer than eye diameter (ED = 22–25% HL). Scales on snout approximately three to five times the diameter of those on occipital region. Eye moderately large, approximately one-fourth head length; pupil oval, crenelated. Ear opening approximately 1.5 times as high as wide, canted posterodorsally to anteroventrally; eye to ear distance longer than diameter of eyes (EE = 129–150% ED). Rostral rectangular, broader than high, divided by a partial

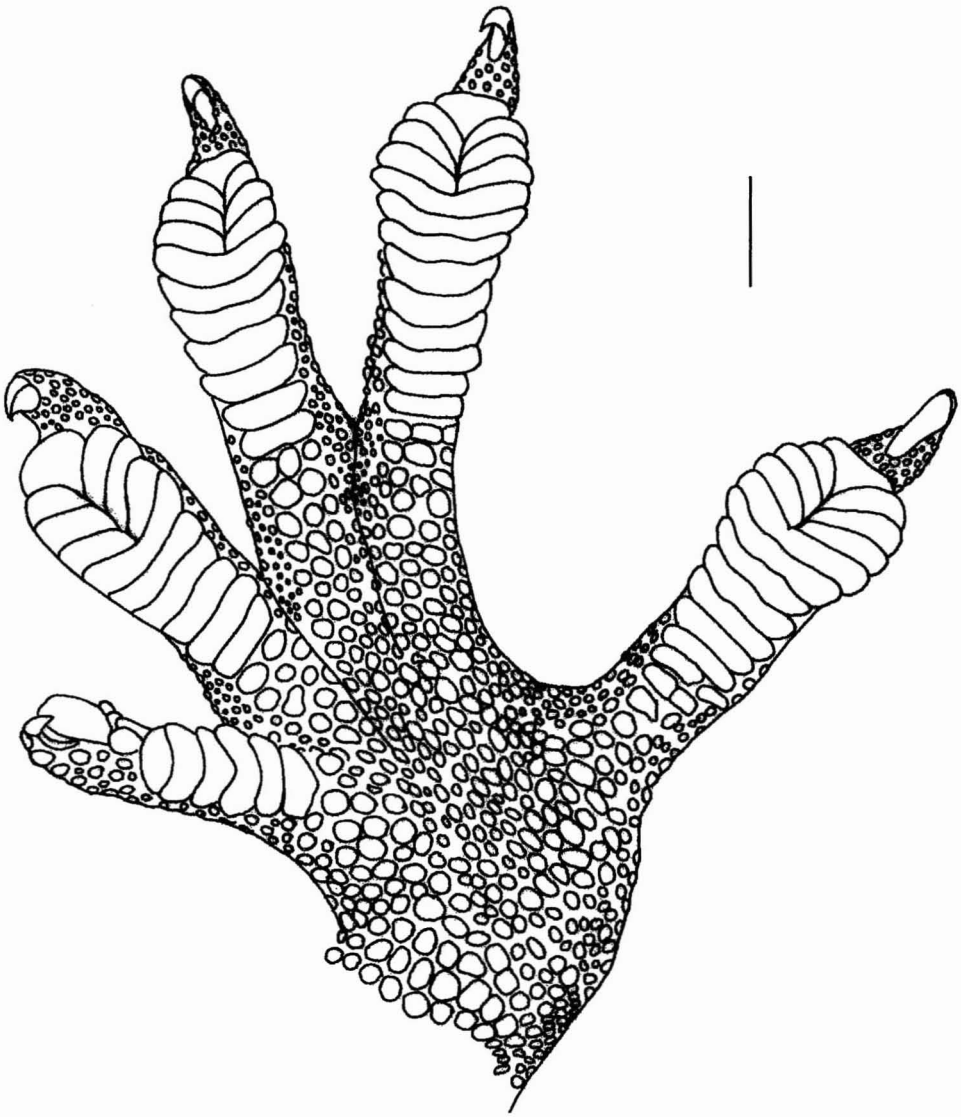

FIGURE 2. Ventral view of right pes of *B. madjo* (paratype, AMS R149329) illustrating the single medial apical scansor on digit I and the restriction of paired subdigital lamellae to the distal portions of the digits. Scale bar = 1 mm.

groove running downward for a distance of 30% of the rostral height, contacted posteriorly by 2 (3) internasals and two large supranasals, contacted posteroventrally by first supralabial. Nostrils oval, anterolaterally oriented, surrounded by rostral, three nasals, one supranasal, and the first supralabial; ventralmost, crescentic nasal small, in contact with first supralabial. Two (three) internasal scales between supranasals. Mental triangular, approximately as broad as deep (1.3 times deeper than broad); first infralabials in broad contact with one another posterior to mental scale (separated by mental and a single, elongate, enlarged postmental scale), each in contact posteriorly with an enlarged

median postmental and one somewhat enlarged chin shield. First row of three chin shields, including postmental, much larger than throat scales, followed by four rows of smaller, but still enlarged, chin shields. Nine (eight) enlarged supralabial scales, of which the fifth through last are beneath eye; seven infralabial scales; 31(38) scale rows between supraciliaries, 15 (1) scale rows across frontal bones at midpoint of orbit. Dorsal scales tiny, homogeneous, slightly conical, granular; ventral scales 2–4 times diameter of dorsals, smooth, flattened, subimbricate, enlarged posteriorly on the body. Posterior abdominal scales rounded, midabdominal scales elongate. Approximately 154 (145) scale rows around midbody. Scales of limbs not differing from dorsals. Scales on palms and soles smooth, flattened. Preanal pores extend to midpoint of thighs, in two long rows of 29 (28) (anterior) and 24 (22) (posterior), with two additional pores in a third row (holotype only). Posterior long row with a medial gap of 1–3 poreless scales. Forelimbs and hindlimbs relatively long, 36 (31)% and 49 (43)% of SVL, respectively, axillary pocket weakly developed. Digits short, all bearing claws, those on digit I of both manus and pes somewhat reduced and partially sheathed, remaining claws long and strongly recurved; relative length of digits of manus: IV ~ III > II ~ V > I, and of pes: IV ~ V > III > II > I; digits weakly webbed; digits III and IV of pes tightly bound along length of elongate metatarsals. Distal subdigital lamellae typically paired, except for terminal lamella, pairs meeting at shallow angle to the transverse axis. Basal lamellae of all digits undivided. The claw of digit I, manus and pes, lies adjacent to a single, large, medially situated apical scansor. Lamellar counts from right side 6-10-11-12-7 (7-11-10-11-12) manus and 7-10-12-14-11 (7-10-11-13-12) pes (includes apical scansors of digit I).

Tail (approximately 24% regenerated in both specimens) 119 (113)% of SVL, slender, roughly oval in cross section; tail base at cloacal spurs distinctly swollen and rounded. Caudal scales small, flat, rectangular, arranged in regular rows. Surface of tail weakly segmented, caudal scale rows forming whorls, each whorl 9 dorsal scale rows and 6 ventral scale rows long; ventral caudals 1.5 times larger than dorsals, midventral caudal scales not enlarged. Scales of pygal region much smaller than (approximately 1/2) those of postpygal region. This junction also marked by an inconspicuous fold of skin at the lateral margins of the tail base. Cloacal spurs consisting of a set of three (two) enlarged domed scales on each side of tail base, borne on a raised mound adjacent to cloaca. An irregular adhesive subcaudal pad visible distally, with setal fields visible microscopically.

Color in preservative (based on holotype): Dorsum cream to light brown. Four evenly spaced, dark brown, somewhat asymmetrical, transverse chevrons, each with darker anterior and posterior borders. Chevrons faded laterally, partially connected to one another on flanks by a broken, dark, longitudinal stripe. Snout dark, with darker canthal stripe continuing beneath orbit to anterior margin of ear. A second dark bar from posterodorsal margin of orbit extends over top of ear, expanding to form a large dark patch on the temporal region and nape. A middorsal dark patch extends from the parietal region to level of anterior margin of forelimb insertion, partially fusing posteriorly with lateral nape markings. A dark brown crossbar connects the anterior orbital borders and a second, more indistinct dark bar across the crown connects posterior orbital borders. Labial scales cream with a darker suffusion on anterior infralabials. Venter beige, unmarked. Limbs pale, speckled with darker brown, especially around knees. Sacrum and tail base marked with a dark chevron. Original portion of tail bearing alternating dark and light bands. Eight darker bands on original tail, each as long to twice as long as adjacent pale interspaces. Interspaces with irregular dark mottling. Tail venter beige with scattered darker patches.

The paratype differs in coloration. Its pattern is less contrasting, consisting of medium and dark brown markings. Dark brown chevrons distinctly connected laterally, enclosing lighter (mid-brown) dorsal patches. A distinct, straight-edged crossbar present on nape. Head markings much less well defined

than in holotype. Labials mid-brown with paler centers. Tail with alternating mid-brown and light brown markings. Lighter markings edged by very dark brown margins, each lighter area one-third to equal to adjacent darker markings. Venter light brown with some darker suffusions, especially on torso and chin.

OSTEOLOGY: Both specimens possesses 26 presacral and 2 sacral vertebrae. The first four presacral vertebrae are without ribs, as is the last presacral. The caudal skeleton includes 5 pygal vertebrae and 16.5 (holotype) or 18.5 (paratype) postpygals anterior to the regenerated portion of the tail. The phalangeal formulas of the manus and pes are unreduced: 2-3-4-5-3 (manus) and 2-3-4-5-4 (pes). Premaxillary tooth loci 11, maxillary tooth loci (unilateral counts) approximately 34, dentary tooth loci (unilateral counts) approximately 34. A single pair of crescentic cloacal bones is present.

COMPARISONS WITH OTHER TAXA: *Bavayia madjo* is a large species exhibiting some features of both the *Bavayia sauvagii* and *B. cyclura* complexes. The existence of a single enlarged medial apical scansor on digit I of the manus and pes is seen elsewhere only in *B. sauvagii* and *B. ornata. Bavayia madjo* differs from both of these species in its greater size (maximum 75 mm SVL versus 62 mm for *B. sauvagii* and 69 mm for *B. ornata*) and in the presence of two or three rows (versus a single row) of preanal pores in males. Multiple preanal pore rows are also found in *B. crassicollis, B. cyclura, B. montana, B. robusta,* and *B. validiclavis,* all of which differ from *B. madjo* in the structure of digit I. *Bavayia madjo* also has a significantly larger total number of preanal pores than all other members of the genus (55 versus a maximum of 40 in *B. montana*) and is the only *Bavayia* in which pores extend well onto the thighs. The absence of yellow ventral coloration further distinguishes *B. madjo* from the members of the *B. cyclura* group, and the dorsal color pattern, although similar to that of some congeners in its basic features, is clearly different than that of *B. pulchella, B. exsuccida, B. validiclavis,* and *B. septuiclavis,* all of which are characterized by distinctive pale vertebral and/or nape markings.

The affinities of *B. madjo* are unclear, but the predominance of features associated with the *B. sauvagii* complex, notably the apical scansor structure, gracile body, and dull ventral coloration, suggests that it may be a high-elevation member of this group.

DISTRIBUTION AND HABITAT: *Bavayia madjo* is known with certainty only from high-elevation forest on Mt. Ignambi and Mt. Panié, both in the northern range of Province Nord. The holotype was found sheltering in a dry rock crevice beneath an overhanging boulder, about 3 m above the ground in an area of closed humid forest. The paratype was collected by day beneath the exfoliating bark of a small dead tree in stunted montane closed forest on the eastern ridgeline of Mt. Panié.

CONSERVATION STATUS: The fact that this distinctive species has not been collected in the more intensely surveyed middle-elevation forests of northern New Caledonia suggests that it is probably restricted to higher elevations in the northeastern ranges of Province Nord. The recent discovery of several new taxa apparently restricted to elevations above ~900 m (e.g., *Nannoscincus rankini* Sadlier, *Marmorosphax montana* Sadlier & Bauer, *Sigaloseps ruficauda* Sadlier & Bauer) highlights the need for additional herpetological surveys at those elevations.

Portions of the habitat of *B. madjo* are formally protected in the Réserve Spéciale Botanique de Mont Panié, but there is currently no active management of this reserve. Although the higher elevations of the Panié Massif are uninhabited, extensive localized habitat destruction has occurred, in part resulting from deer and feral pig damage (Jones 1998).

DISCUSSION

The description of *Bavayia madjo* brings the number of recognized species in the genus to 12, making *Bavayia* the most speciose

lizard genus in New Caledonia. This situation parallels that of *Caledoniscincus* and *Nannoscincus* among the endemic skinks, with several widespread forms, as well as high-elevation endemics and geographically circumscribed regional endemics (Sadlier et al. 1999*a,b*). These examples clearly illustrate that substantial in situ speciation has occurred within the New Caledonian mainland. Indeed, Bauer (1989), and Bauer and Sadlier (1993) proposed that such "continental" (as opposed to archipelagic) cladogenetic events have dominated the evolution of the highly endemic herpetofauna of the New Caledonian region. *Bavayia* and numerous other regionally endemic lizards therefore provide strong evidence to refute earlier claims (e.g., Diamond 1984) that New Caledonia is too small to support a radiation of endemic vertebrates. It is also apparent that resolution of the taxonomic morass currently associated with the ill-defined *B. cyclura* and *B. sauvagii* complexes will further elevate the number of diagnosable, independently evolving lineages within the genus.

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LITERATURE CITED

BAUER, A. M. 1989. Reptiles and the biogeographic interpretation of New Caledonia. Tuatara 30:39–50.

———. 1990. Phylogenetic systematics and biogeography of the Carphodactylini (Reptilia: Gekkonidae). Bonn. Zool. Monogr. 30:1–219.

BAUER, A. M., and R. A. SADLIER. 1993. Systematics, biogeography and conservation of the lizards of New Caledonia. Biodiv. Lett. 1:107–122.

BAUER, A. M., A. H. WHITAKER, and R. A. SADLIER. 1998. Two new species of the genus *Bavayia* (Reptilia: Squamata: Diplodactylidae) from New Caledonia, Southwest Pacific. Pac. Sci. 52:342–355.

DIAMOND, J. 1984. Biogeographic mosaics in the Pacific. Pages 1–14 *in* F. J. Radovsky, P. H. Raven, and S. H. Sohmer, eds. Biogeography of the tropical Pacific. Bernice P. Bishop Mus. Spec. Publ. 72.

JONES, J. P. G. 1998. Lizards of New Caledonia, a report of the herpetological work of Diadema '98. (Unpublished; available from Department of Zoology, Cambridge University, Cambridge, U.K.) 16 pp. +2 pl.

ROUX, J. 1913. Les reptiles de la Nouvelle-Calédonie et des Iles Loyalty. Pages 79–160 *in* F. Sarasin and J. Roux, eds. Nova Caledonia, Zoologie, Vol. 1, L. 2. C. W. Kreidel's Verlag, Wiesbaden, Germany.

SADLIER, R. A. 1989. *Bavayia validiclavis* and *Bavayia septuiclavis,* two new species of gekkonid lizard from New Caledonia. Rec. Aust. Mus. 40 [1988]: 365–370.

SADLIER, R. A., A. M. BAUER, and D. J. COLGAN. 1999*a*. The scincid lizard genus *Caledoniscincus* (Reptilia: Scincidae) from New Caledonia in the Southwest Pacific: A review of *Caledoniscincus austrocaledonicus* (Bavay) and description of six new

species from Province Nord. Rec. Aust. Mus. 51 : 57–82.

SADLIER, R. A., A. M. BAUER, and A. H. WHITAKER. 1999*b*. The scincid lizard genus *Nannoscincus* Günther from New Caledonia in the Southwest Pacific: A review of the morphology and distribution of species in the *Nannoscincus mariei* species group, including the description of three new species from Province Nord. Zool. Neocaledonica (in press).

WRIGHT, J. L., A. M. BAUER, and R. A. SADLIER. 2000. Two new gecko species allied to *Bavayia sauvagii* and *Bavayia cyclura* (Reptilia: Squamata: Diplodactylidae) from New Caledonia. Pac. Sci. 54 : 39–55.